342

Good Practice Guide

Undertaking an Industrial Energy Survey

Paper and Board industry supplement

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Undertaking an Industrial Energy Survey

Paper and Board industry supplement

Introduction

GPG 342 is a supplement Guide to *"Good Practice Guide 316: Undertaking an Industrial Energy Survey"*. The purpose of this supplement is to point the way to positive practical energy saving solutions specific to the Paper and Board industry. The emphasis is on non-integrated mills since paper, board and tissue are mainly manufactured directly from imported pulp or recycled waste materials in the UK.

Paper manufacturing is not a single process but a series of linked and interdependent operations. Energy cost savings can be achieved through improved pulping, reduced refining, faster draining, efficient pressing and reduced dryer load.

Generally the main driving force for modifications usually relates to increased production or the need to modify furnish usually from softwood to predominantly short fibres or waste material. However, it is essential to take account of energy efficiency when a plant is modified or replaced as this will often provide payback on the investment in energy cost savings.

The topics featured in this Guide relate to the major papermaking plants and processes. The aim is to assist Mill Engineers and Energy Managers in identifying savings areas and determining where the most effort should be focussed:

- **Topic 1 Pulping**
  This is affected by the source and condition of the furnish, with energy demand typically in the range 30-150 kWh/t, dependent on furnish
- **Topic 2 Refining**
  The correct balance of cutting and fibrillation has the most significant impact on energy used to produce a given product, usually ranging from 150-700 kWh/t
- **Topic 3 Drying and Pressing**
  Efficient drying is crucial to both mill costs and the development of the required paper characteristics and accounts for the main mill energy demand typically 1,000-3,000 kWh/t.

For each topic there are three sections. The first covers 'What to Look For' in terms of the typical operation of the process. These points are linked to a more detailed 'Potential Opportunities', in the third section, ranging from low/no cost to measures requiring capital investment. Pointers to gathering data and information on the energy related operation of a plant and other 'Tips and Tricks' are set out in the second section. The overall aim is to give guidelines to focus on specific areas of plant operation and to identify areas where there are inconsistencies, or problems, thus highlight opportunities for energy cost savings.

Other important areas already covered in the main Good Practice Guide 316 include pumping, compressed air and boiler plant operation.

Topic 1 **Pulping**

What to Look For

- There is an interaction between the degree of disintegration in a pulper and the effect of subsequent refining. Stock, which is too lightly pulped, produces a poorer and more variable quality stock after refining. Prolonged pulping will, dependent on the degree of subsequent refining needed, make no beneficial contribution to the final stock quality.(1)
- Is the operation of the pulper(s) matched to the paper machine output?(2 and 5)
- Batch pulper rotor running between cycles unnecessarily.(3)
- If the rotor cannot be stopped, is the pulper kept empty when not needed?(3)
- With secondary and recycled fibres, are slushing times extended for chemical action to take effect in high consistency de-inking processes, and also reducing subsequent higher energy refining?(2)
- Does the level of over pulping, dependent on the degree of subsequent refining needed, have any useful contributory effect to the final stock quality?(2)
- Pulpers directly heated by steam rather than hot water make-up.(7 and 8)
- Are broke pulpers using the minimum power when the paper machine is running normally?(3)

Numbers in brackets relate to numbered points under Potential Opportunities on the following page.

Survey Tips & Tricks

Optimum consistency depends on the furnish and the characteristics of the pulper.

Examine daily operating pattern and batch cycle times of the pulper for any over run. Look for unexplained idling times or losses.

Use hour-run and installed metering to develop a measure of energy input for quantity of material processed over shifts or batch operation periods.

Monitor pulper power consumption on a regular weekly basis and compare against similar stock processing and known previous production conditions.

Compare output and operations with manufacturers' recommendations and design parameters.

Topic 1 **Pulping**

Potential Opportunities

1 Pulping and refining processes are interdependent as some fibre development takes place during pulping thereby affecting the amount of refining. As specific energy usages are lower for the pulping process it should be feasible to optimise the degree of pulping to minimise overall energy demands. This is particularly relevant when the pulper is run in batch mode and when hardwood stock predominates.

2 Savings in pulping energy of 5% and upwards of 15% or more may be found through optimising the slushing duration for particular pulp types. A test parameter is needed such as tensile strength or burst strength, linked to sample testing. With softwoods there is little fibre development in the pulper and a lower level of slushing may be sufficient to maximise throughput.

3 If pulper demand is low, it may be possible to schedule the operation so that the rotor is stopped between cycles. Where the pulper has to run continuously consider adding pulp when the tub is only partially full. This reduces the cycle time to allow the pulper either to run for longer at low load when empty or to achieve greater throughput.

4 Ongoing monitoring of weekly pulper performance should be linked to regular inspections of rotor and vane condition and operation as well as maintenance schedules.

5 Stock preparation control can be used to automate and maintain process efficiency for uniform consistency in the stock chest. This may be achieved by linking to tank level measurement, pulper cycles and loadings to control consistency.

6 A further option may be to pulp at higher consistencies to reduce working times and to allow the rotor to be stopped longer, but with due regard to additional pumping requirements. Alternatively, a lower cost option would be rotor replacement.

7 Generally where new plant is needed to significantly boost stock production, new pulper design and characteristics should be also assessed in terms of energy consumption as well as improved pulp break-up for better consistency and improved strength. The key elements, which determine the energy consumed, are rotor design; baffle position and vanes; and bedplate configuration.

Paybacks with new plant would typically be 2-4 years based on energy costs and this approach would be a way of mitigating the costs against improved process energy efficiency, over and above any product throughput gains and requirements. Factors affecting energy use are stock consistency; stock temperature; and tub shape, and these all need to be optimised. Dependent on the furnish, a separate deflaker can also be beneficial in more efficiently defibring the pulp and improving product throughput.

8 The use of recycled or secondary fibres in the pulping process increases energy requirements at the pulping stage, but refining needs may be reduced as the fibres have already been through the process. Secondary fibre pulpers should preferably be filled with hot water which may be available via heat recovery rather than from steam. Insulate external surfaces of heated pulping vessels and pipework to reduce heat losses.

Further Information

- GPG163 Energy Efficient Pulping/Slushing in Paper Manufacture
- GIL015 Modern Low Energy Paper Production
- GIL053 Optimising Energy Use in Pulpers and Refiners
- GPCS128 Hot Stock Dispersion in a Paper Mill Using Waste Paper in its Furnish.

Topic 2 **Refining**

What to Look For

- Many refiners are incorrectly sized or not well maintained which results in a high no load power that reduces refiner efficiency. Methods for achieving energy cost savings vary in complexity and cost and the inter-relationship of refining with other papermaking processes, particularly drying and pulping, means that the total effect of measures taken needs to be assessed.[4 and 5]
- Refiners can be an open-ended use of power and there is a tendency to over-refine, with no reference made to energy cost.[1, 2 and 3]
- Over refining of product with the consequence of a poorly drained and wetter web. Stock subsequently then entering the press has poorer draining qualities leading to increased energy requirements for both pressing and drying.[1, 2, 3 and 6]
- Systems designed for softwood furnish now handling predominantly short fibre furnish with consequent difficulties and inefficiencies.[6, 7, 8 and 9]
- More effective pulping can reduce refining energy use.[2 and 3]
- Effect of fillings wear: regular no-load measurement can identify worn fillings and also worn refiners.[1 and 4]

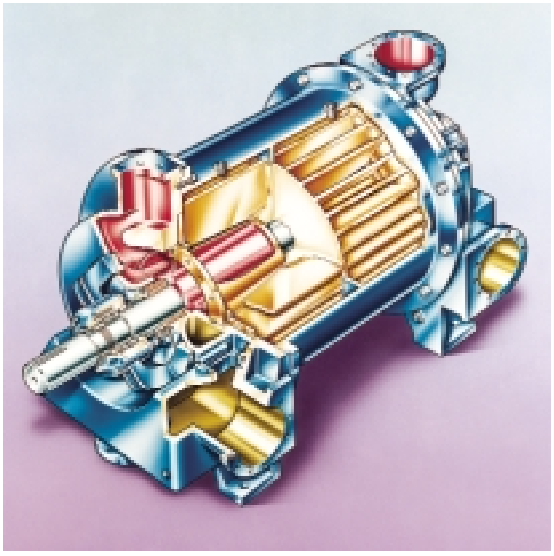
Numbers in brackets relate to numbered points under Potential Opportunities on the following page.

Survey Tips & Tricks

Examine energy consumptions over the process and correlate to output and furnish type.

Monitor no-load power requirements of the refiner by examining metering; modern units should have efficiencies of 75-80% but older plant may be working below 50%.

Where significant changes in flow have occurred consult the manufacturer to establish whether changes in filling pattern are required.



Topic 2 **Refining**

Potential Opportunities

1 Use kWh metering to monitor and manually control the batch refining process, initially set up using test sheets and wetness testing, for example Schopper Reigler tests. This represents a minimal cost option where stock is consistent.

2 Control of power only offers a low-cost form of control, especially where the product mix is always the same. Control of energy is preferable where there are a number of diverse products, as this form of control can respond to variations in flow and consistency. Constant power control maintains refiner power at a given set point. The system can range from a simple ammeter or kWh meter at one end to a power controller. However when furnish changes such as consistency or flow vary, the refiner set point is maintained and specific energy changes cause the stock to be over- or under-refined.

3 With diverse product mixes, control of energy is preferable as this can provide response to variations in both flow and consistency. This assesses both process flow and consistency and adjusts power to maintain a constant input to the stock. Savings of 8-10% can be achieved in refining energy by optimising stock quality levels.

4 A reduction in no-load demands may be obtained by refiner refurbishment or appropriate fillings design. Proper maintenance and fillings can provide lower no-load demand and raise efficiencies by up to 10%. Ongoing monitoring of performance should be linked to reviews of refining intensity and operation as well as maintenance schedules.

5 Correct fillings can alleviate some of the problems of incorrect refiner sizing, but an alternative approach is to use recirculation loops with multiple units to maintain a more steady flow through the refiners. The main benefit is usually a means of keeping minimum flow and pressure in the refiner within safe operating limits, rather than energy efficiency.

6 There are many systems which were designed primarily for softwood furnish that are now unable to cope with a predominantly short fibre furnish. In some cases it is possible to modify an existing system with conversion from mixed refining with all components treated equally in the same refiners to either sequential or separate refining. Separate refining can be more efficient than mixed refining as it allows bar patterns to be selected that are best suited to the fibre being refined. There is the practicality of selecting fillings and changing bar and groove widths. Where existing refiners can be used, with modifications to pipework and pumping arrangements, paybacks can be 6-12 months, with savings of up to 25%. Pipework modifications are generally more cost effective than replacement refiners.

7 Variable speed drives can be used for refiners to change rotation speed and refining intensity. Although energy savings can be achieved the main benefit is flexibility in terms of fillings and refining intensity, where different furnishes are used.

8 New fibre refiners offer potential energy improvements when replacing older types, albeit at a premium in capital investment. Many standard refiners are not optimised for low energy use, with high no-load power resulting in low operating efficiency, less than 50% in many installations. More modern refiners have lower no-load power requirements, with efficiencies of 75% up to 82%. Energy cost savings can produce a payback of 2-3 years.

9 Multi-disk refiners can be more suited to short fibred pulps and some wastepaper grades. The high cost can give paybacks of between 1½ to 3 years.

Further Information

- GPG114 Energy Efficient Refining of Papermaking Stock
- GIL053 Optimising Energy Use in Pulpers and Refiners
- NPFP099 Multi-Disk Refining at a Paper Mill.

Topic 3 **Pressing and Drying**

What to Look For

- Increases in refining energy can close up paper pore structure making subsequent drying more difficult thus reducing overall production rates.[3 and 9]
- The drying section of the process consumes around 90% of the steam demand of a typical paper mill. Less energy is used in removing water from the web by mechanical means than by evaporation.[9]
- Monitor product dryness leaving the press section; a 1% increase in dryness leaving the press results in a 4% decrease in steam consumption of the drying section. There is a balance between removing water at the wet end and in presses through increased electrical power for presses and vacuum against the value of the lower cost steam saved.[9 and 12]
- Examine compliance of final product dryness and overall evenness of quality. Poor moisture profile is usually corrected by overdrying.[6, 11 and 12]
- Cylinder wall finish and cleanliness and close contact between the feedstock and the cylinder external surface will affect drying rates.
- Characteristics of both the paper and the type of felt used will affect operational efficiencies.
- Reduce broke pulping/waste levels.
- Consider the degree of discretion allowed to operators to manually override the automated process.

Numbers in brackets relate to numbered points under Potential Opportunities on the following page.

Survey Tips & Tricks

Make sure that water can be efficiently drained away from the forming section in the most effective manner. Check collection points, weirs, pipe-work and sumps for downstream blockages.

Ensure proper maintenance of the vacuum system removing water through the suction boxes. Check seals for condition and leakage. Power is wasted if too high a vacuum is maintained, so ensure adequate levels are maintained and that controls are operable and accurate.

Monitor dryer inlet and outlet air temperatures and flows over daily/weekly operations. Link to product throughput and moisture levels to establish a heat and mass balance for overall drying operations. Develop a figure for energy input per kg water evaporated, (theoretical minimum is 0.63 kWh/kg water).

Make comparisons with manufacturers recommended figures and, where applicable, between individual drying lines. Discuss with staff any subsequent modifications or changes away from design criteria. Repeat measurements on a regular basis to establish trends.

Examine suitability and efficacy of drying mechanism controls. Are end point temperature and humidity controls installed and working correctly? Does any cycling occur leading to uneven levels of processing?

Reduce overall heat loss and minimise fresh air input by employing a suitable level of air recirculation. Excessive recycle rates however will limit dryer efficiency as humidity levels rise.

Less energy is used in removing water from the web by mechanical means than by evaporation; check on moisture levels at the interface.

Is there adequate removal of condensate and uncondensed gases from within drying cylinders? Is uneven distribution of the steam supply over the internal surface affecting paper condition?

Significant energy is used in pumping and air handling. Consider pump and fan efficiencies and their control mechanisms. Are variable speed controls used in preference to damper arrangements?

Topic 3 **Pressing and Drying**

Potential Opportunities

1 Develop a Monitoring and Target System to compare operations over extended periods and between plant lines or runs.

2 Correct scheduling of machines and production.

3 Look at de-bottlenecking caused by imbalance between plant capacities and efficiencies in the separate pulping, refining and drying processes.

4 Examine steam and condensate system for best efficiency, control and savings potential.

5 Design/rebuild the steam and condensate system to improve quality and at the same time reduce energy consumption. An advanced steam and condensate system can allow adjustment of temperature gradient through the dryer sections in a controllable and reliable way.

6 Optimising cross shell temperatures and moisture content is helped by correct siphon design and turbulator bars.

7 Accurate closed loop exit air temperature control gives steady state drying operations with minimum fluctuations in loads.

8 Insulate dryer surfaces to minimise heat losses.

9 Establish a balance between removing water by pressing, with increased electrical power for presses and vacuum compared with higher steam use associated with thermal drying.

10 Many of the developments in drying techniques have been dictated by the need to keep pace with the increased speed of modern paper machines, without introducing an excessive number of cylinders. Supplementary infra-red (IR) or gas warm air heaters are the usual option. Also, consider the use of air caps on individual cylinders e.g. machine glazed (MG) and Yankee cylinders.

11 Another aid to drying is the ventilation of the web between cylinders i.e. dryer pocket ventilation.

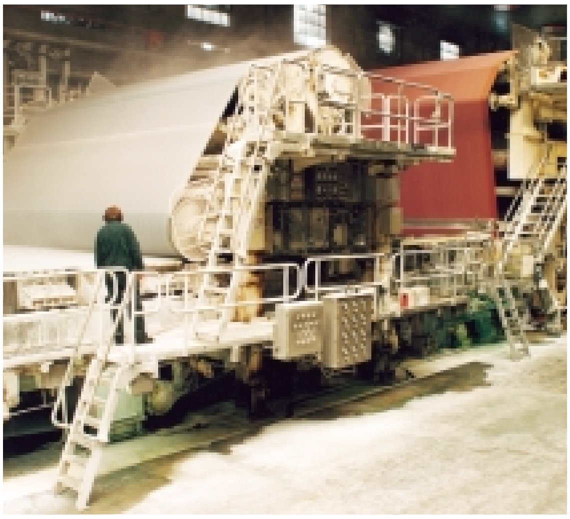
12 Control extraction of moist air from the machine and consider fitting dryer hoods where not already installed, either canopies or totally enclosing hoods.

13 Heat recovery potential from dryer exhaust streams should be investigated as a longer term measure, with paybacks of around 2-3 years. The most effective use for recovered heat is to heat air used for the ventilation of the drying section of the machine.

14 Consider the option of CHP installation where not already in place at the mill to provide steam and power. This is a longer term measure with a typical payback of 3-4 years.

Further Information

- NPFP052 Optimisation of a Yankee Drying Cylinder Hood
- GIL015 Modern Low Energy Paper Production.



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